Transformational PBN NAS

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Topics

• Performance Based Navigation (PBN) Strategy
• Wide Area Augmentation System (WAAS) Update
• Ground Based Augmentation System (GBAS) Update
• VOR Minimal Operational Network (MON)
• Instrument Landing System (ILS) Rationalization
• GNSS Intentional Interference & Spoofing Study Team (GIISST)
• Satellite Operations Coordination Concept (SOCC)
• Questions
Performance Based Navigation (PBN) Strategy
The 2025 Vision

• Four Focus Areas
  – Creating a PBN NAS
  – Decision Support Tools to enable better PBN utilization
  – Agile Above and fixed below 10,000 feet
  – Align legacy infrastructure to supplement PBN
Developing the Vision - 2025 NAS

- RNAV for all Operations
- Reduced Victor Airways
- PBN Route Structure
- Re-work NRS

Level 1 Metroplex
Level 2 Metroplex
Level 3
Level 4
Level 5

RNAV/GPS

Ground-based Infrastructure
Challenges Still Being Addressed

• Standardize and execute training and education for pilots and controllers
• Make what we have built work better, using lessons learned and available expertise
• Establish tools and policies to manage equipage and capability differences, if mandates will not be pursued
• Clear priorities to insure resources are used for the best value
PBN Accomplishments

More than double PBN procedures since 2009

- RNAV STARs: 2009 - 100, 2014 - 309
- RNAV SIDs: 2009 - 175, 2014 - 416
- RNP-AR Approaches: 2009 - 137, 2014 - 384

Of Public Airports with published IAP:
- 98% have a PBN IAP
- 25% with only PBN IAP

Oceanic separation standards reduced with RNP

RNAV SIDs and STARs at over 80% of ASPM77 airports

Reduced, separation standards for closely-spaced approaches

Increased use of TMA with transition towards TBFM

152 New RNAV OPDs
Creating a PBN NAS

Leverage PBN for operational improvements in VMC and IMC, while maintaining a resilient navigation capability. Simplest PBN tool for the job.

• **Policy:**
  – Guidelines for which tools will be used when
  – Clear guidelines for performance levels across a range of situations

• **Operation:**
  – All approaches are vertically guided
  – Overlay program for departures and arrivals
  – Implement PBN Route Structure
  – Final WAAS procedure deployment

• **Infrastructure:**
  – PBN infrastructure with required resiliency
  – NDB/VOR procedure draw down

• **Culture:**
  – Address barriers to utilization, specifically training and resource availability

2025 Vision

5 Year Focus
Wide Area Augmentation System (WAAS)
WAAS Development Phases

• **Phase I: IOC (July 2003) Completed**
  – Included Development of a robust safety architecture
  – Included establishment of WAAS expert panel to evaluate potential integrity threats

  – Completed a Safety Risk Management Decision (SRMD) to support LPV-200 (VAL of 35m)
  – Expanded WAAS coverage to Mexico and Canada while modifying the System to address observed ionospheric threats

• **Phase III: Full LPV-200 Performance (2009 – 2013)**
  – Completed System updates to improve performance during moderate ionospheric activity
  – Supported continuous monitoring of system data that contributes to continued integrity assurance
  – Began transition of Second Level Engineering from contractor based to organic FAA capability

• **Phase IV: Dual Frequency (L1,L5) Operations (2014 – 2044)**
  – Includes the transition from use of L2 to L5 in WAAS reference stations
  – Infrastructure modifications to support future L1/L5 user capability
  – Support sustainment of WAAS GEOs
Ground Based Augmentation System Update (GBAS)
FAA GBAS Program

• Validation of ICAO SARPS for the baseline set of GBAS Approach Service Type D (GAST-D) Requirements
  – GAST-D to support approach and landing operations using CAT III minima by augmentation of single frequency GPS (L1)
  – Validation includes work producing commercial prototypes (Avionics/Ground system)
  – SARPS Validation – April 2015
    • Likely that close of validation will be conditional on completion of IGM work (and possibly resolution of VDB issues)
  – Final Close of Validation – Fall 2015

• SLS-4000 GAST C Block II Schedule
  – Modification of previously approved SLS-4000 Block I configuration intended to enhanced system availability
  – Block II System Design Approval (SDA) is expected summer 2015
Recent Accomplishments

• Airport Operations (Status: Jan 2015)
  – Total 1277 approaches / Average 90/month
  – Newark, NJ / 582 Operations (737/787)
  – Houston, TX / 695 Operations (737/787/A380/B747-8)

• US Airlines
  – United Airlines Equipage
    • B 737 – 97 aircraft / B 787 – 14 aircraft
  – Delta Airlines
    • B 737 – 34 Aircraft / Total order of 112
    • Planning to equip also Airbus fleet (A350, A321)

• 106 Boeing customers with GLS
  – B737 67 airlines / 900 aircraft/3660 provisioned
  – B747-8 10 airlines / 84 aircraft
  – B787 29 airlines / 235 aircraft
Recent Accomplishments

- **Coordinated International Airline Operations in the US**
  - Newark (since Sept 2014)
    - British Airways - B787
      - 138 GLS approaches
  - Houston (since Dec 2014)
    - Emirates - A380 (11 GLS approaches)
    - Lufthansa - A380 (9 GLS approaches)
    - Cathay Pacific - B747-8 (7 GLS approaches)
VOR Minimal Operational Network (MON)
VOR MON Program Overview

• The FAA will transition to Performance-Based Navigation (PBN) from the conventional VOR-defined routes and procedures
  – Improved Efficiency and Capacity

• The Transition to PBN provides an opportunity to reduce the aging unneeded infrastructure
  – The FAA currently has ~958 federally-owned and operated VORs (including VORTACs and VOR/DMEs), Most are 30+ years old
  – Few aircraft are actually using VOR to fly the VOR Airways

• The VOR MON Program plans to discontinue approximately 30% of the VORs in the National Airspace System (NAS) by 2025
  – VOR MON will provide a conventional backup coverage during a GPS outage as well as basic navigation for VOR-only aircraft
  – Supports FAA NAS Right Sizing Initiative
VOR MON Strategy and Notional Timeline

- **FY14**: VOR MON Implementation starts.
- **FY15**: WAAS LPV procedures at qualified runways.
- **FY20**: ADS-B equipage mandate takes effect.
- **FY25**: APNT full operational capability.

Timeline:
- **2014**: IARD
- **2015**: FID 1
- **2020**: FID 2
- **2025**: VOR MON Implementation
Instrument Landing System (ILS) Rationalization
Overview

• The Instrument Landing System (ILS) Rationalization is a NAS Efficiency Streamlining Services (NESS) initiative for the FAA to strategically remove ILS infrastructure within the NAS without impacting safety, efficiency, or operations.
RATIONALIZATION OBJECTIVE

• Maximize cost savings while retaining airport access and safety benefits of vertically guided approaches

  – Rationalize the need for Category I ILS where the runway end has duplicate capability
    • ILS, LPV,LNAV/VNA

  – Including Operation during GPS Outages
    • Continued operations for airliner aircraft
    • Safe Landing for all aircraft
Preliminary Assumptions, March 2015

- Timeframe for Rationaization: 2018-2030
- All ILS that provide CAT II/III service will be retained
- Retain vertical guidance at all runway ends that currently have vertical guidance
- Decision does not encompass removing Approach Lighting or Runway Visual Range
- CAT I services will be reassessed based upon current and projected aircraft equipage
GNSS Intentional Interference & Spoofing Study Team (GIISST)
GIISST Background

• GNSS is vulnerable to intentional interference and spoofing
  – Intention and capabilities exist to adversely impact safety, security, and capacity of the NAS
  – Topic is subject of growing public awareness

• FAA Navigation Programs and Aircraft Certification established GIISST in Oct. ‘12 to
  – Examine threat assessments, studies, and data
  – Develop specific, actionable recommendations
## Threat Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Examples of Experienced Events</th>
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<tbody>
<tr>
<td>Low Power Mobile Interference</td>
<td>Interference at airport caused by personal privacy devices in vehicles on adjacent roadways</td>
</tr>
<tr>
<td>Low Power Stationary Interference</td>
<td>Interference at airport caused by stationary personal privacy device in aircraft operations area</td>
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<tr>
<td>High Power Interference</td>
<td>Misuse or unplanned use of military equipment results in jamming</td>
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<tr>
<td>Unintentional Re-radiator</td>
<td>Improper use of aviation GPS test equipment</td>
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<tr>
<td>Pinpoint Spoofing Attack</td>
<td>Partially demonstrated (research, test for hovering UAV with non-aviation grade equipment and pre-determined knowledge of vehicle position/time)</td>
</tr>
<tr>
<td>Coordinated Spoofing Attack</td>
<td>No known event for civil, approved, aviation applications</td>
</tr>
<tr>
<td>Coordinated Interference and Spoofing Attack</td>
<td>No known event for civil, approved, aviation applications</td>
</tr>
</tbody>
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GIISST Summary

• GNSS is vulnerable to intentional interference and spoofing
• FAA’s GIISST has developed recommendations to address this vulnerability

Next Steps

• Provide recommendations to aviation community
  – RTCA SC-159
  – PBN Aviation Rulemaking Committee (PARC)
Satellite Operations Coordination Concept (SOCC)
As the transition to a PBN and ADS-B NAS continues to expand, reliance on the GNSS will increase.

What would result if an anomaly in the GNSS caused it to be unavailable for a portion or all of a flight?
The Role Envisioned for the SOCC

- Monitor all available sources of the GNSS for anomalies and outages
- Assess the impact to determine which routes, and instrument flight procedures are affected
- Provide Air Traffic authorities with an impact statement
  - Enhance situational awareness resulting in improved traffic flow management
- Disseminate information to other users and stakeholders in the NAS
Benefits

• Provide detailed information on affected routes, route segments, instrument flight procedures and ADS-B based surveillance
• Minimize the effect and allow for improved traffic management and less delay
• SOCC automation will reduce the time to process and disseminate critical information
• The SOCC will complement the use of the Alternate Positioning, Navigation and Timing (APNT) system
  – Knowledge of where APNT will be needed will allow air traffic authorities to adjust traffic flows to accommodate possible reduced separation standards in the affected area
Questions